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AN EXPERIMENTAL STUDY ON STRENGTH PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH QUARTZ SAND

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ABSTRACT

In civil engineering construction concrete plays a major role. The ingredients in concrete are cement, fine aggregates, coarse aggregates and water. Due to the scarcity of river sand which is used as fine aggregate in concrete, is being replaced by the products of metamorphic rocks such as quartz sand. It occurs in most igneous and practically all metamorphic and sedimentary rocks. It is highly resistant to both mechanical and chemical weathering. The primary aim of this project is to compare the strength properties of M25 grade concrete by partial replacement of fine aggregate with quartz sand. In order to find the strength of concrete, destructive tests (compressive strength and split tensile strength) and non-destructive test (rebound hammer test) are conducted.

KEYWORDS: Compressive Strength, Rebound Hammer Test, Split Tensile Strength Concrete & Quartz Sand

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Original Article

INTRODUCTION

Concrete is the most widely used material on earth after water. Many aspects of our daily life depend directly or indirectly on concrete. Concrete is prepared by mixing various constituents like cement, aggregates, water, etc. which are economically available. Concrete is unique among major construction materials because it is designed specifically for particular civil engineering projects. Concrete is a composite material composed of granular materials like coarse aggregates embedded in a matrix and bound together with cement or binder which fills the space between the particles and glues them together. Concrete plays a critical role in the design and construction of the nation's infrastructure. Almost three quarters of the volume of concrete is composed of aggregates. To meet the global demand of concrete in the future, it is becoming a challenging task to find suitable alternatives to natural aggregates for preparing concrete.

According to some estimates after the year 2010, the global concrete industry will require annually 8 to 12 billion metric tons of natural aggregates. "During the past 25 years, the production of crushed stone has increased at an average annual rate of about 3.3 percent. Production of sand and gravel has increased at an annual rate of less than 1 percent. Production of crushed stone, which is expected to increase by more than 20 percent, will be about 1.6 billion metric tons, while production of sand and gravel will be just under 1.1 billion metric tons, an increase of 14 percent. In essence the amount of crushed stone to be produced in the next 20 years will equal to the quantity of all stone produced during the previous century i.e. about 36.5 billion metric tons. "Therefore the use of alternative sources for natural aggregates is becoming increasingly important.

Quartz is the most important sand-forming mineral and occurs in very many sand types but usually not exclusively. In this sand type (which is aptly named quartz sand), quartz is almost the sole component of sand.

OBJECTIVES OF THE STUDY

This study reports the usage of Quartz sand that is found prevalently in Florida and is used as a sand replacement for material in the concrete mix. Optimal dosage range of this Quartz sand is chosen based on concrete mix studies. The ultimate focus of this work is to ascertain the performance of concrete mix containing Quartz sand and compare it with the conventional concrete mix. This is expected to

- Partially replace fine aggregate with quartz sand in concrete as it directly influences economy in construction.
- Design and proportion the concrete mix for M25 grade concrete, as per the recommendation of IS: 10262:2009.
- Find the fresh and hardened properties of concrete mixes by partially replacing sand with Quartz sand.
- Check the variation of Compressive strength, Split Tensile Strength, and rebound hammer studies by partially replacing the fine aggregate from 0% to 100% with Quartz sand, compare with conventional concrete mix and plot the corresponding graphs separately.

MATERIALS USED

Ordinary Portland cement of 53 grade was used in the experiment.

Cement specific gravity: 3.15

The specific gravity of fine aggregate (river sand) is2.47 and it is of Zone-III.

Table 1: Properties of Fine Aggregate

Properties	Test Values
Specific gravity	2.47
Fineness modulus	2.65

The specific gravity of fine aggregate (quartz sand) is 2.32 and it is of Zone-III and fineness modulus is 4.2.

The specific gravity of coarse aggregate is 2.92

Table 2: Properties of Coarse Aggregate

Properties	Test Values
Specific gravity	2.92
Water absorption	18.24
Fineness modulus	3.71

EXPERIMENTAL INVESTIGATION AND METHODOLOGY

Experimental investigation was planned to compare the strength characteristics of quartz sand concrete and natural sand concrete without using any admixtures. Tests were conducted on materials to know their physical properties. M25 concrete has been used as reference mix. The main objective of the present work was to study the effect of percentage replacement of natural sand with quartz sand in 0%,25%, 50%,75% and 100% respectively as required for the strength properties of concrete. The study was carried out on M25 grade concrete with 0.5 water cement ratio.

Cubes of standard size 150mm*150mm*150mm (length * breadth * depth) were cast and tested for 7, 14 and 28 days for compressive strength for both Destructive and Non Destructive (Rebound hammer) tests. Standard cylinders of size 150mm*300mm (length * breadth) were cast and tested for 7, 14 and 28 days split tensile strength.

RESULTS AND DISCUSSIONS

Tests like Compressive strength, split tensile strength and Workability tests are conducted for concrete made of different replacements of sand with quartz sand for 7, 14 and 28 days of curing. The specimens are tested for 7,14 and 28 days for 0%, 25%, 50%, 75%, 100% replacement of quartz sand. The results are tabulated and discussions have been recorded as follows.

Compressive Strength

Table 3: Compressive Strength with Different Replacement Percentage of Quartz Sand

% OF QUARTZ SAND REPLACEMENT	AVERAGE 7 DAYS COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE 14 DAYS COMPRESSIVE STRENGTH (N/mm^2)	AVERAGE 28 DAYS COMPRESSIVE STRENGTH (N/mm^2)
0%	6.8	26.5	30.98
25%	8.9	34.2	52.8
50%	33.95	54.18	58.48
75%	45.30	56.09	65.07
100%	41.23	40.53	50.26

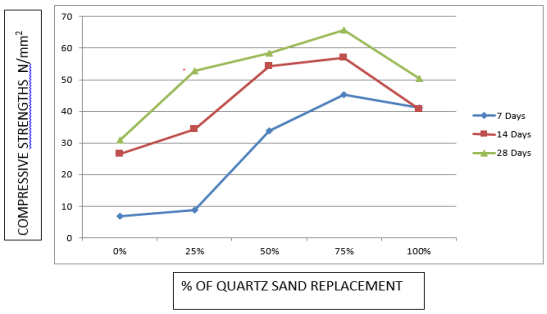

Figure 1

Split Tensile Strength

Table 4: Split Tensile Strength with Different Replacement Percentages of Quartz Sand

% of quartz sand replacement	Average 7 Days Split tensile strength (N/mm^2)	Average 7 Days Split tensile strength (N/mm^2)	Average 28 Days Split tensile strength (N/mm^2)
0%	3.4	5.78	4.56
25%	6.2	8.15	6.99
50%	10.13	13.59	12.5
75%	12.18	14.96	14.63
100%	10.93	14.3	15.23

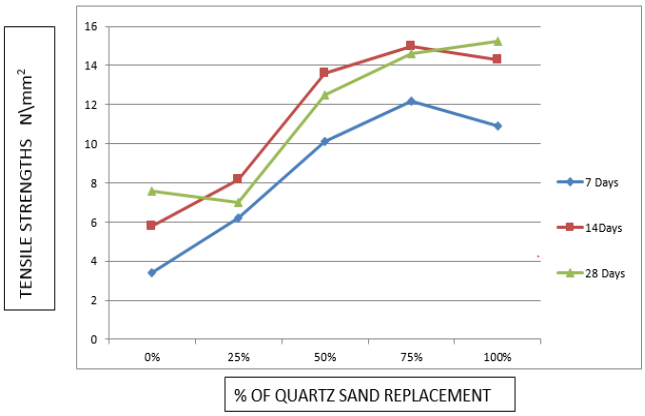

Figure 2

Rebound Hammer Test

Table 5: Rebound Hammer Test for Different Replacement Percentages

% of Quartz sand replacement	28Days
0%	29
25%	30
50%	32
75%	39
100%	41

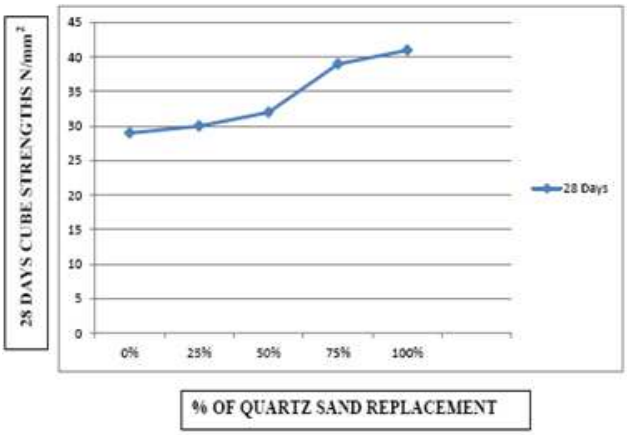

Figure 3

CONCLUSIONS

Based on the analysis of experimental results and discussions, the following are the conclusions.

- The compressive strength split tensile strength, rebound hammer of normal concrete and concrete with quartz sand as partial replacements are compared It is therefore observed that the strength of the normal concrete is slightly parallel to the replaced concrete.
- The compressive strength increases with the increase in percentage of quartz sand up to 75% compared to the weight of fine aggregate.

- The split tensile strength increases with the increase in percentage of quartz sand up to 100% compared to the weight of fine aggregate.
- From the results of compressive strength and split tensile strength of 7, 14 and 28 days curing, 100% replacement of fine aggregate by quartz sand is the optimum percentage of replacement of M25 grade concrete.
- The rebound hammer test results of concrete improved gradually from 0% to 100% and attained a maximum value at a replacement of 100% quartz sand in fine aggregate, while compared to the controlled specimen.
- The following benefits can be obtained by using quartz sand
  - Cost reduction.
  - Utilization of waste material is possible in construction by using quartz sand as a partial replacement material for fine aggregate in concrete.

SUGGESTIONS FOR FUTURE RESEARCH

- A much more extensive field study on a concrete structure made with quartz sand used in the mixture could be conducted and changes in durability and mechanical properties could be investigated and correlated to laboratory results.
- The long term behavior of concrete with quartz sand could be studied and its compatibility with reinforcing could be analyzed in the future.
- Studies are also suggested on the petro graphic examinations of concrete samples with quartz sand to elicit insight of the actual behavior of concrete. The relationship between entrained air and entrapped air in concrete could also be studied.
- Due to the presence of several dangerous heavy metals and salts in the quartz sand, leaching tests could be carried out to verify its environmental compatibility

REFERENCES

1. *Babu, J., and N. Mahendran. "Experimental studies on concrete replacing fine aggregate with blast furnace slags." International Journal of Engineering Trends and Technology.*
2. *Aggarwal, P., Y. Aggarwal, and S. M. Gupta. "Effect of bottom ash as replacement of fine aggregates in concrete." (2007): 49-62.*
3. *Narayani. P and Ramya. G, Dr. Sivanthi Aditanar. Experimental Study on Concrete Using Copper Slag as Replacement Material of Fine aggregate.*
4. *Arumugam. K , Langovan. R James Manohar. D, A study on characterization and use of Pond Ash as fine aggregate in Concrete.*
5. *Deshpande, NEELA., Kulkarni, S. S., Pawar, TEJASWINEE., & Gunde, VIJAY. (2014). Experimental investigation on strength characteristics of concrete using tyre rubber as aggregates in concrete. International Journal of Applied Engineering Research and Development, 4(2), 97-108.*
6. *K. Shiteesh Gaur, Jyotsana. Use of Plastic as Partial Replacement of Fine Aggregate inFiber Reinforced Concrete.*

7. *M. S. Kuttimarks , R.. Shruthi . Experimental Studies on Replacement of Fine Aggregate with Glass and Fly Ash.*
8. *Shyam Prakash. K, Kommineni Hemanthraja. Replacement of Fine Aggregate by using Recyclable Materials in Paving Blocks.*
9. *Meenakshi Dixit, Atishaya Jain, Dinesh Kumawat. Replacement of Fine Aggregate in Concrete with Municipal Solid Waste Bottom Ash from Incinerator.*
10. *E. Divya, R. Shanthini, S. Arulkumaran . Study OnBehaviour of Concrete Partially Replacing Quartz Sand As Fine Aggregate.*
11. *M. Iqbal Malik, Muzafar Bashir, Sajad Ahmad. Study of Concrete Involving Use ofWaste Glass as Partial Replacement of Fine Aggregates.*
12. *Yadav, D., & Gaikwad, A. (2015). Comparison and testing of tensile strength for low & medium carbon steel. International Journal of Mechanical Engineering (IJME), 4(5), 1-8.*
13. *M. R. Divya, Prof. M. Rajalingam, Dr. Sunilaa George. Study on Concrete with Replacement of Fine Aggregates by Vermiculite.*